SECTION 2

Site Information

This section provides information on methane and frames the regulatory requirements for post-closure gas control at landfills in California. These requirements form the basis for the objectives of the remedial action (i.e., what levels of methane are allowable around the landfill and what controls are required). This section also provides background information regarding the operational history of Landfill 26, configuration of the cap at the landfill, land use surrounding the landfill, and previous investigations conducted at the landfill. The section also describes the geologic/hydrogeologic conditions of Landfill 26.

Methane is a colorless, odorless gas with a wide distribution in nature. It is the major component of natural gas. At room temperature, methane is lighter than air. Methane is not toxic when inhaled but can cause suffocation by reducing oxygen levels in areas that are not ventilated. Methane is combustible; mixtures of about 5 to 15 percent in air are explosive when sufficient oxygen is present. At these levels methane can pose an explosive hazard if not controlled or reduced.

Most modern municipal landfills typically generate significant volumes of various gases (including methane) during their active life and for a period of time after closure. Landfill gas is generated by bacterial activity that decomposes decaying materials in the refuse. In landfills where oxygen is limited, anaerobic bacteria are primarily present and methane is the predominant landfill gas generated. Oxygen is limited in many landfills because of the soil or other types of cover placed on the landfill. The conditions in which a landfill is likely to generate or release gases is unique to each landfill.

2.1 Regulatory Framework

Federal regulations, RCRA Subtitle D, part 258, contain requirements for operations, design, and closure of municipal landfills. The ECRA Subtitle D requirements apply only to landfills that contain “household waste” as defined under RCRA, but are relevant and appropriate for only landfill that contains decomposable organic matter. As part of the RCRA Subtitle D process, California became an “approved” state, which means that the landfill regulations within California were deemed to meet the Subtitle D requirements and, consequently, landfills within California must meet the state requirements in lieu of Subtitle D requirements. California Code of Regulations (CCR), Title 27, contains the state requirements for landfill design, operation, and closure/post-closure. The responsible party (usually the owner) of a closed landfill in California is required to perform regular postclosure monitoring and maintenance for the postclosure maintenance period, a minimum of 30 years. Included in these requirements are landfill gas perimeter probe monitoring, gas system operation (if one is present), and gas control.

The applicable compliance standard for landfill gas control at municipal solid waste landfills, CCR Title 27, Section 20919.5(a), requires that the methane concentration at a site’s property line (unless an alternative point of compliance has been established) not exceed the lower explosive limit (LEL) for methane (which has an LEL of 5 percent by volume in air). Per this regulation, the LEL is defined as the lowest percent, by volume, of explosive gas in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure. If this regulatory limit is exceeded at the landfill's point of compliance, the landfill owner is required to monitor for the presence and movement of landfill gas, and to take necessary action to protect public health and safety, and property, and to prevent further offsite migration of landfill gas. In general, these requirements are:

- Immediate public notification
- Validation of the detected exceedance
- Preparation of a plan to address the exceedance
- Implementation of control measures

The closure and postclosure maintenance documentation and requirements for Landfill 26 were outlined in the *Final Closure and Postclosure Maintenance Plan* (Final Plan) (CH2M HILL, 1999). This document defines the postclosure landfill gas monitoring program for the site. As described in the ROD, the Army has agreed to follow Title 27 in preparing the Final Plan and implementing postclosure monitoring and maintenance. The landfill gas monitoring program approved in the Final Plan consisted of annual monitoring of probes GMP-5 through GMP-15, during the late summer or early fall, when groundwater elevations are lowest. These probes are currently the landfill's "point of compliance" for landfill gas monitoring (meaning that these probes are the locations were the compliance standards described previously in this section are applicable).

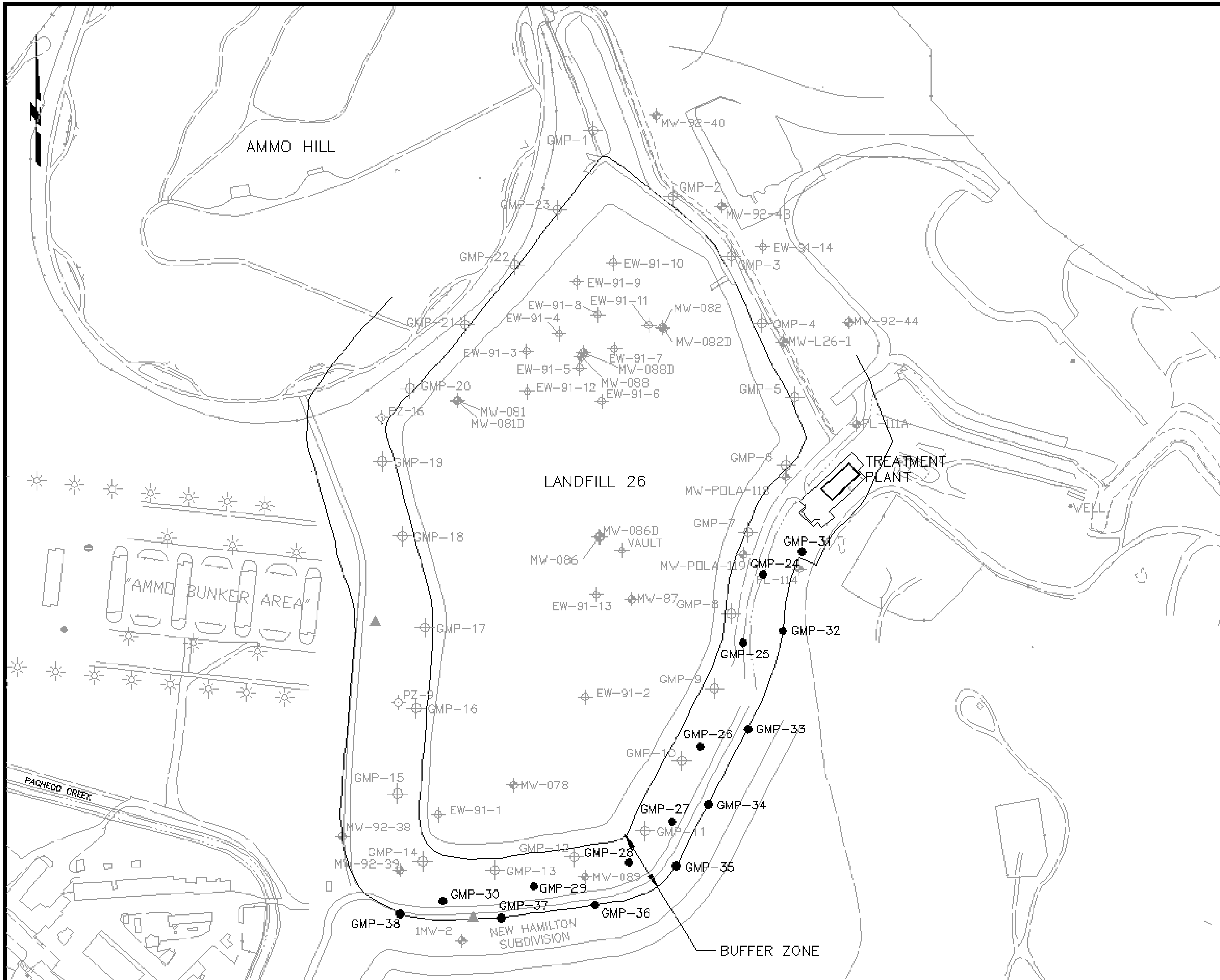
The Army is in the process of installing additional probes (Figure 2-1). Eight of the new probes will be located at the property boundary. The compliance standards will apply to these probes once they are installed, moving the point of compliance to the property boundary.

Supplemental monitoring was performed from July 13, through December 15, 2000, as described in Section 2.5. The monitoring schedule will be reevaluated when the additional probes are installed. Samples collected as part of annual monitoring have been, and will continue to be, collected and analyzed for the following compounds, in accordance with the Final Plan:

- Carbon dioxide
- Oxygen
- Nitrogen
- Methane
- Methylene chloride
- Benzene

Although Title 27 requires analysis for methane only, the additional compounds listed above are evaluated annually to comply with the Final Plan.

Following the installation of the new probes, USACE will begin a program to sample GMP-5 through GMP-15 and the new probes on a monthly basis for a period of one year, beginning April 2001. The probes will be analyzed for methane.



LEGEND:

MW-82	MONITORING WELL
EW-91-1	EXTRACTION WELL
GMP-22	GAS MONITORING PROBE
	PIEZOMETER
	APPROXIMATE LOCATION OF NEW NAVY MONITORING WELL, NOT MONITORED DURING SUPPLEMENTAL MONITORING PROGRAM
GMP-30	PROPOSED GAS MONITORING PROBE LOCATION

CH2MHILL

0 125 250
FEET

FIGURE 2-1:
PROPOSED GAS MONITORING PROBE LOCATIONS
DECEMBER 11, 2006

CLIENT:
U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

LOCATION:
HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

Source: ITSI Innovative Technical Solutions, Inc., 2001

The City of Novato is proposing recreational use of the landfill. However, CCR Title 27 regulations include specific requirements for design and monitoring for the presence of methane in structures within 1,000 feet of a landfill and on the owner's property. Specific buffer regulations are a function of local policy within California; none are in place for this site. Accordingly, in the Final Plan, the Army included buffer requirements, as presented in Section 2.3.2 of this report. These requirements will limit construction of structures or alteration of drainage patterns on the landfill and in the buffer zone.

The Bay Area Air Quality Management District (BAAQMD) has specific requirements for control of methane emissions from active landfills. These regulations may need to be considered, depending on the remediation option that is selected.

2.2 Landfill Operational History

Landfill 26 began receiving refuse in the early 1940s. It was expanded throughout the 1960s and 1970s. Construction wastes are believed to have been the primary waste deposited in the landfill (USACE, 1993). Field examinations by WCC and the 548th Explosive Ordnance Control Center confirmed that a variety of these materials, as well as scrap metal, airplane parts, and buried culverts were present (WCC, 1987). No unexploded ordnance was found (WCC, 1997). Methods of disposal within Landfill 26 were not documented. The landfill has been inactive since 1974, when the base was listed as surplus property.

Detailed records were not maintained about the types or amounts of waste disposed of in Landfill 26. Commercial wastes and demolition materials are believed to have been placed in the landfill. Landfilling methods are unknown. The refuse has been estimated to average between 5 and 8 feet thick; sampling indicated that it is mostly saturated by groundwater (WCC, 1997) The volume of the landfill, excluding final cover, was estimated to be approximately 6.1 million cubic feet (151,300 cubic yards) (WCC, 1987).

On the basis of the available description, Landfill 26 is shallow, small, old, wet, and has a high percentage of non-degradable components compared to a typical modern, municipal solid waste landfill in California. Therefore, it would be expected that, when compared to modern, municipal solid waste landfills in California, Landfill 26 would have a lower overall production of methane, that Landfill 26 would have a lower overall production of methane, that Landfill 26 has passed its expected peak production of methane.

Landfill 26 was closed in 1994-1995, following a Record of Decision (ROD) signed in August 1989. Based on the ROD and a 1992 Explanation of Significant Differences (ESD) prepared by the Army, a modified remedy, consisting of a RCRA-type landfill cap, was selected as the means of closure in 1992. The USACE Omaha District designed this remedy. Waste Discharge Requirement (WDR) Order No. 92-029 required that Landfill 26 be closed. WDR Order No. 96-113 required a closure plan as well, and required that any further closure activities be conducted in accordance with the CCR in effect at that time. Negotiations with the California Department of Toxic Substances Control (DTSC) and the San Francisco Bay Regional Water Quality Control Board (RWQCB) required a closure and postclosure maintenance plan. There were 23 gas-monitoring probes (GMP-1 through

GMP 23) installed around the perimeter of Landfill 26 in 1994 as part of the landfill closure (see Section 2.5 for additional details).

A Groundwater Treatment Plant and extraction system was designed and installed between 1992 and 1993 to provide hydraulic containment under the landfill and to treat extracted water. The system consists of 14 extraction wells, a treatment plant along Aberdeen Road (east of the landfill), and a conveyance system to carry the groundwater from the wells to the treatment facility (see Section 2.4.2 for additional details). Following construction of the closure cap, collection of several additional years of groundwater monitoring data, and a comprehensive evaluation of other existing data for the landfill, it was determined that contaminants from Landfill 26 have not significantly impacted groundwater outside the Landfill 26 boundary. Therefore, with the concurrence of the RWQCB, it has been determined that extraction and treatment of groundwater are not necessary to protect human health and the environment (WCC, 1997). At some time in the future, and with the approval of regulatory agencies, the system will be decommissioned according to the *Groundwater Treatment System Decommissioning* report, dated February 1998 (CH2M HILL, 1998b).

2.3 Land Use

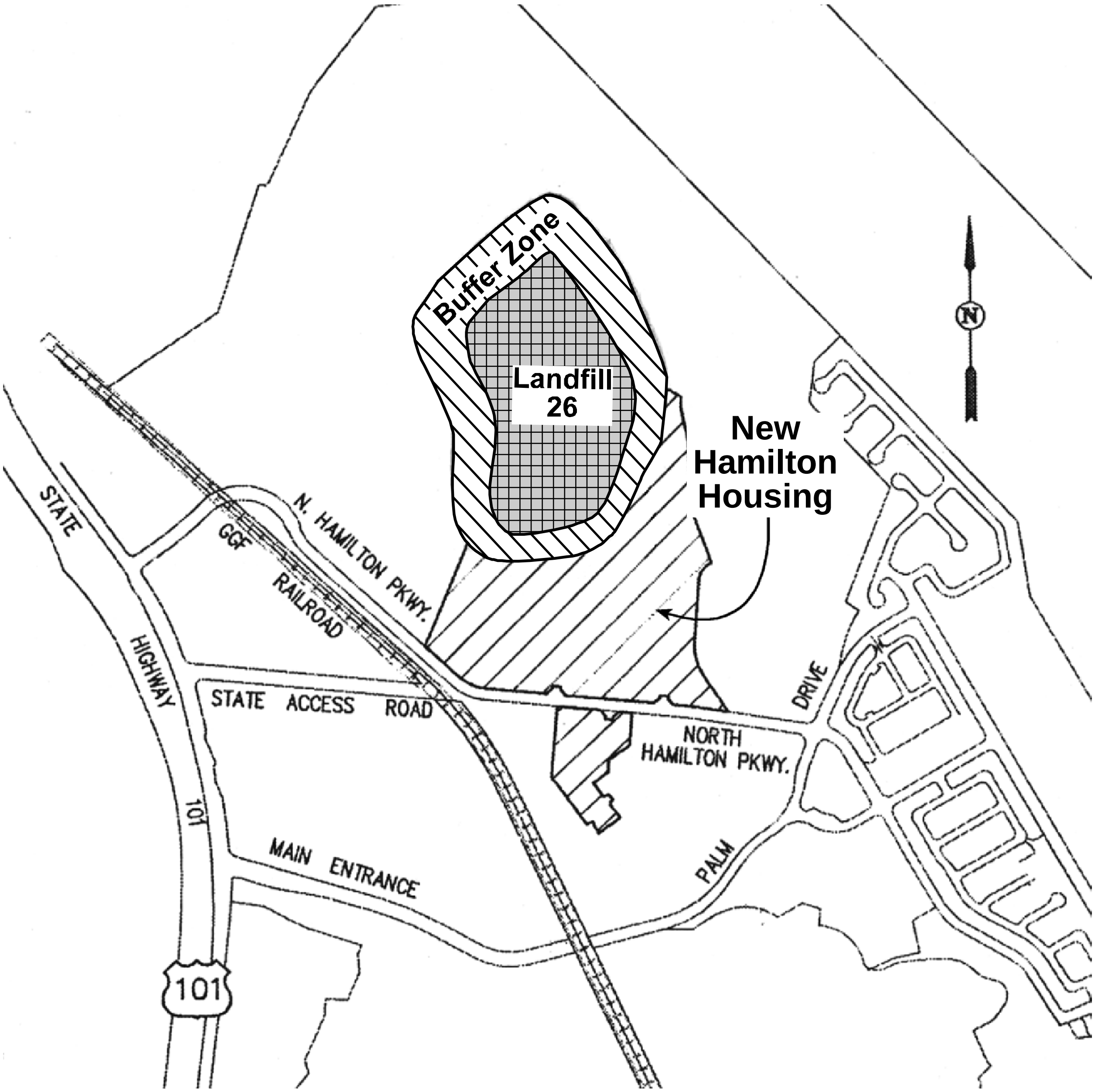
2.3.1 Land Use Surrounding Landfill 26

Following the closure of HAAF in 1994, the area surrounding Landfill 26 was typical of a closed airfield: abandoned barracks and residences, an unused runway to the east of the site, and other unused maintenance buildings. Most of the former structures have been removed. In 1995, a Reuse Plan was developed for much of the HAAF property, including Landfill 26 and adjacent areas. The Reuse Plan identified 12 planning areas. One of the planning areas included approximately 415 acres at HAAF that were transferred to the New Hamilton Partnership (NHP). Landfill 26 lies within the northern one-third of the NHP parcel. However, the landfill remains government property.

Currently Landfill 26 is bordered to the:

- **West** by open space along Ammo Hill
- **North** by the former northern portion of the main airfield now designated for wetlands restoration
- **East** by open space along the former Petroleum, Oil, and Lubricant (POL) Hill
- **South** and s**outheast** by residential housing that is under construction by Shea Homes

Structures present in the vicinity of the landfill include the inactive groundwater treatment plant for Landfill 26 (Figure 2-1) and residential homes currently under construction (see Figure 2-2). A discussion of infrastructures recently placed in support of the residential construction is provided in Section 3.4.3.



Not To Scale

Figure 2-2
Proposed Housing
Hamilton Army Airfield
Novato, California

CH2MHILL

2.3.2 Land Use at Landfill 26

The Army will retain ownership of HAAF Landfill 26 during the postclosure maintenance period. At some point in the future, the City of Novato may take fee title to Landfill 26, with the Army retaining responsibility for monitoring and any required maintenance to the cap. Numerous development concepts for the landfill have been discussed in the past several years, including a ballpark and a Scottish Greens golf course. In accordance with the approved Final Plan (CH2M HILL), postclosure land uses will be limited to those activities that will not affect the integrity, performance, or ability of the Army to maintain and monitor the final cover system.

The Final Plan (CH2M HILL, 1999), lists the following limitations for postclosure land use on and around the closed landfill. Given the various restrictions and limitations, permanent structures on and around Landfill 26 shall be limited to the following:

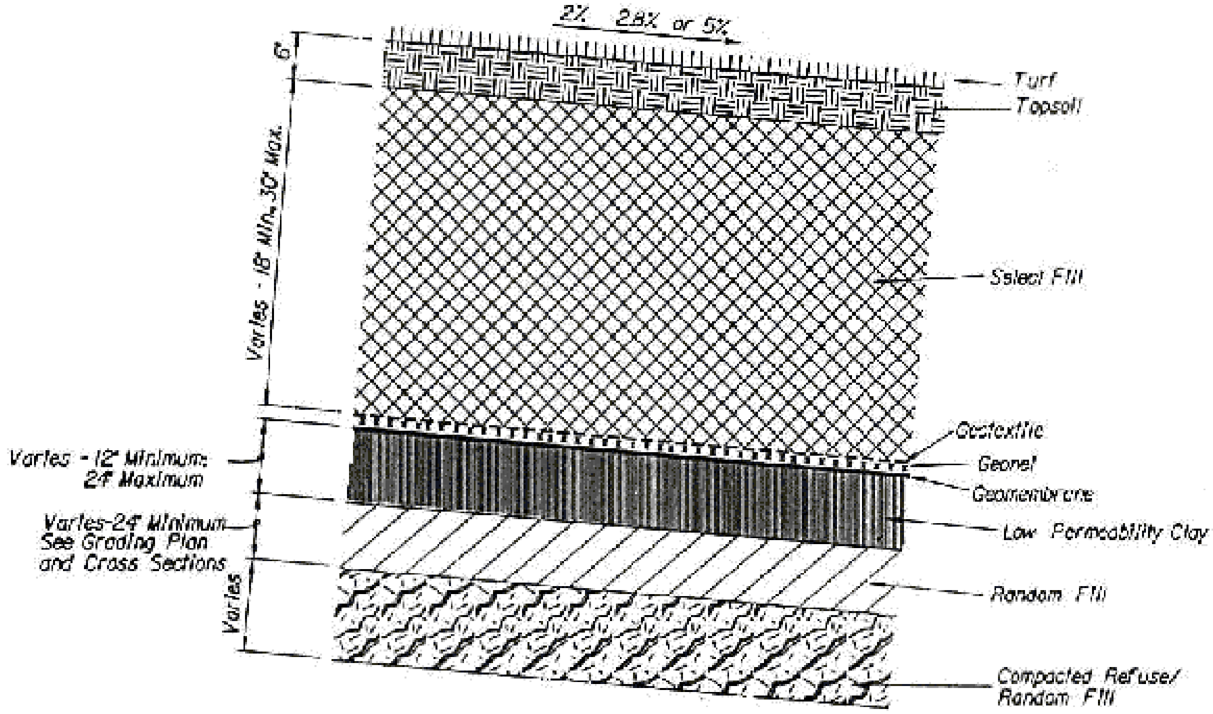
- **On Top of the Landfill:** No residential structures will be permitted. Other permanent structures that could potentially impact the integrity, performance, or monitoring requirements of the final cover system will also not be allowed. Structures that add negligible surface loading to the cap, such as portable toilets, will be allowed. Other structures, such as a shallow foundation for a chain-link fence, would need to be evaluated on a case-by-case basis, based on the restrictions presented above, and submitted to the CIWMB for review (pursuant to CCR Title 27).

- **Within the 150- to 200-Foot Buffer Zone:** No residential structures will be permitted. Other permanent structures that could potentially impact the integrity, performance, or monitoring requirements of the final cover system will also not be allowed. Access ramps to the top deck cover area and structures, if properly designed and appropriately located as presented in Section 3.3.3 of the Final Plan (CH2M HILL, 1999), will be allowed (including within the area of Landfill 26). A perimeter access road and parking area will be allowed only if no additional surface water is routed to Landfill 26 drainage and monitoring system, and if it does not impact the flood-protection berm to the south and southwest of Landfill 26.

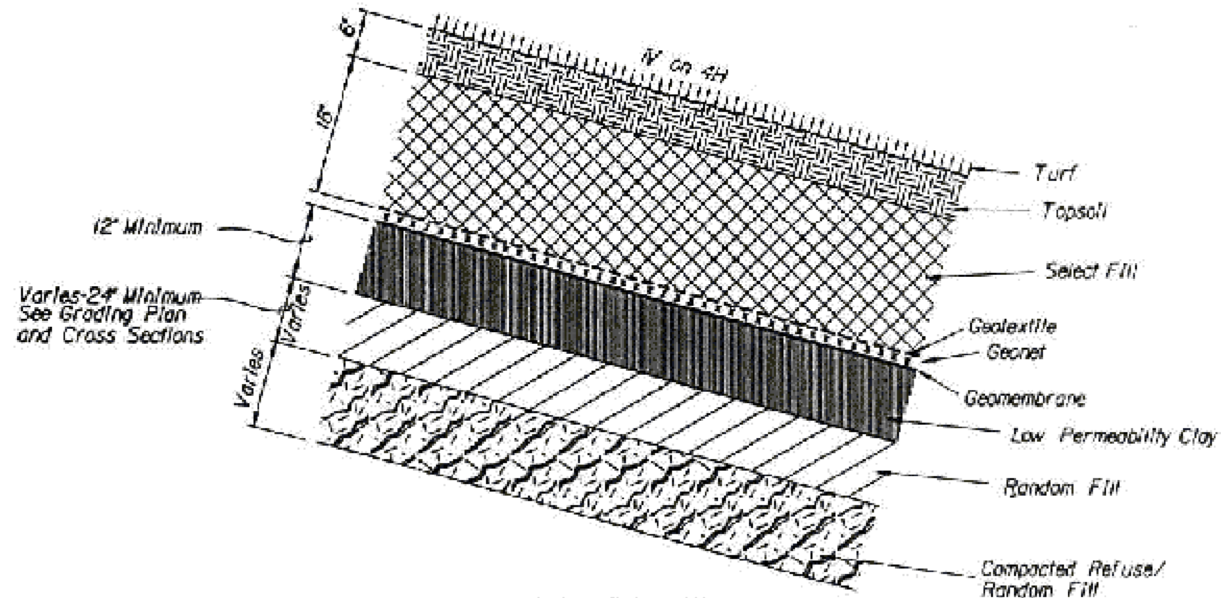
2.4 Landfill Configuration

This section discusses the landfill final cover system, including the closure cap and ancillary features. A schematic cross-sectional drawing of the installed final cover is shown in Figure 2-3. The extent of the cover system and the drainage control features are shown in Figure 2-4.

Although portions of the refuse within Landfill 26 are saturated by groundwater, the primary function of the low-permeability cover system is to minimize the infiltration of rainfall into the waste mass, thereby reducing the potential for waste contaminants and the byproducts of degradation to percolate into the groundwater. However, because landfill gas production requires moisture, reducing the rate and quantity of infiltration into the landfill will likely increase the length of time during which landfill gas is produced, while reducing the quantity produced at any one time.



DETAIL A
TYPICAL TOP DECK CAP
NO SCALE



DETAIL B
TYPICAL SIDE SLOPE CAP
NO SCALE

CH2MHILL

NO SCALE

FIGURE 2-3:
CROSS SECTION DETAILS OF LANDFILL 26 CAP

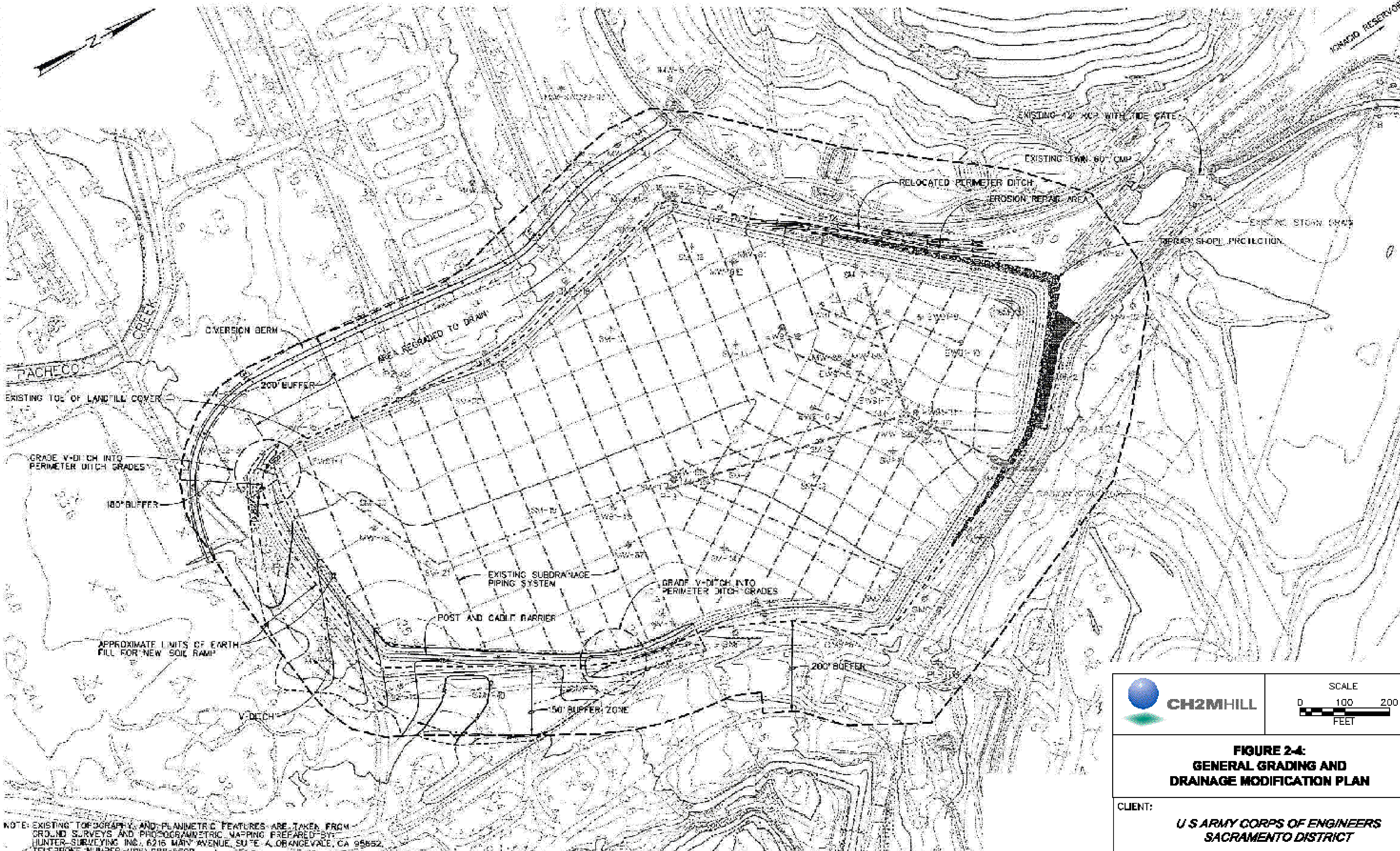
CLIENT:

U S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

LOCATION:

HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

Source: Plant reclamation and Clark & Witham, Inc. Site operation and maintainance manual, Hamilton AFB, Novato, California, remedial action landfill 26, phase II, 1995



NOTE: EXISTING TOPOGRAPHY AND PLANIMETRIC FEATURES ARE TAKEN FROM GROUND SURVEYS AND PHOTOGRAMMETRIC MAPPING PREPARED BY: HUNTER-SURVEYING INC., 6216 MAIN AVENUE, SUITE A, ORANGEVALE, CA 95662, TELEPHONE NUMBER (916) 989-5600.

DATE OF PHOTOGRAPHY: NOVEMBER 25, 1996 AND FEBRUARY 13, 1997.

CH2MHILL

SCALE

0 100 200

FEET

FIGURE 2-4:
GENERAL GRADING AND DRAINAGE MODIFICATION PLAN

CLIENT:

U S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

LOCATION:

HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

To enhance the HAAF Landfill 26 final cover system's performance in water removal, many components were included in the closure:

- Drainage-control system designed to rapidly convey runoff away from the landfill
- Erosion-control measures and gradual slopes to minimize the potential for erosion of the soil layers of the final cover system

Sealed "pipe-boot"-type penetrations of the final cover system's geomembrane to reduce the potential for introduction of water through these penetrations (monitoring system components)

On the basis of studies performed in 1986 (WCC, 1986), 1992 (Quadrel Services, 1992) and 1993 (USACE Omaha District), the original design component of the RCRA cap did not include a gas collection or venting system because the respective studies concluded that Landfill 26 was non-methanogenic and no detection of methane above 0.1 percent was observed. A gas monitoring network was installed around the perimeter of the landfill as part of the RCRA cap and landfill closure.

2.4.1 Landfill Closure Cap

The cap at Landfill 26 was constructed in a manner that meets or exceeds CCR Title 27 performance standards and prescriptive cover system criteria. Title 27 landfill closure caps must consist of a vegetative soil layer, hydraulic barrier layer, and foundation layer. The completed final cover for Landfill 26 includes these three layers, as well as the following components from top to bottom (Figure 2-3):

Vegetative Soil Layer – This layer serves to support plant growth and provides a protective cover for the hydraulic barrier system. Plant growth stabilizes the soil cover system and reduces the potential for long-term erosion. This layer also stores rainfall so that it is available for root uptake. An additional benefit is that healthy root growth will enhance uptake of soil moisture and will reduce the amount that percolates to underlying layers. Finally, the lower, non-soil portion of this layer consists of a lateral drainage component (geonet). This material is highly permeable and functions to drain excess water away from the cover system before it can percolate through the hydraulic barrier layer. Specific components are:

- Vegetative cover
- Topsoil (6-inch-thick soil layer)
- Select fill (18 to 30 inches of clayey-silty-sand with gravel from the Sonoma Company Rock Quarry)
- Geotextile (Amoco 4504 [1005 polypropylene] with subdrainage piping)
- Geonet (J-Drain 200 [FNF])

Hydraulic Barrier Layer – This layer functions to reduce the potential for rainfall infiltration to reach the underlying waste. The hydraulic barrier layer constructed at Landfill 26 is a composite system, meaning that it has two highly effective barrier layer materials stacked together, providing superior performance to one layer only. An additional function of this hydraulic barrier layer is that it restricts the upward movement of landfill gas and gas- and moisture-borne contaminants, making it highly unlikely that contaminants could migrate through the cap, where they could come into contact with humans or animals. Specific components in this layer are:

- Geomembrane, (40-mil-thick, very-low-density-polyethylene [VLDPE] geomembrane)
- Low-permeability clay (12 to 24 inches thick)

(Note: as effective as the hydraulic barrier is designed to be to prevent water from entering the landfill, it can also act to seal the landfill surface and prevent gas from escaping from the surface within the landfill.)

Although geomembrane anchor trenches are commonly used in larger landfills, it is not clear whether these anchor trenches are present at Landfill 26. On the basis of a review of landfill-closure design plans, cover construction as-builts, and the cover system Contractor Quality Assurance report, there is no documentation that these trenches were used to anchor the geomembrane at Landfill 26.

Foundation Layer – This layer supports the hydraulic barrier layer materials. It also protects the hydraulic barrier layer from underlying waste materials that could possibly damage the hydraulic barrier layer. Additionally, it will bridge some minor differential settlement, reducing the impacts of differential settlement on the hydraulic barrier layer. Specific components of the foundation layer are:

- Existing Cover
- Random fill (2 to 4.5 feet thick from Borrow Area [BA] 1 and BA 3)
- Relocated fill (from the “panhandle” area of the landfill, also known as the “finger of waste”)

The report *Construction Quality Assurance Report, Hamilton Army Airfield, Landfill 26 Phase II, Final Cover System* (CQA Report) (CH2M HILL, 1998a) documents closure construction and testing activities. The Site Operations and Maintenance (O&M) Manual (Plant Reclamation, 1996) provides detailed specifications for the materials used in the final cover system and for any necessary repairs.

2.4.2 Ancillary Components and Facilities

The current final cover layout with the groundwater monitoring, gas monitoring, and extraction-well network is shown on Figure 2-5. As part of closure, 22 settlement monuments were established on the cover surface to monitor settlement of the cover system. These monuments must be maintained in place throughout the duration of the postclosure maintenance period.

As part of cover system construction, groundwater extraction wells were installed within the landfill and piped to the onsite groundwater treatment plant. The piping layout is shown on Figure 2-6. Piping, ranging in size from three-quarter-inch to 2-inch diameter, and a 1-inch air line, both were placed within the vegetative soil layer, between the initial and final lifts of select fill (ITSI, January 2001). The treatment plant location is shown on Figure 2-6.

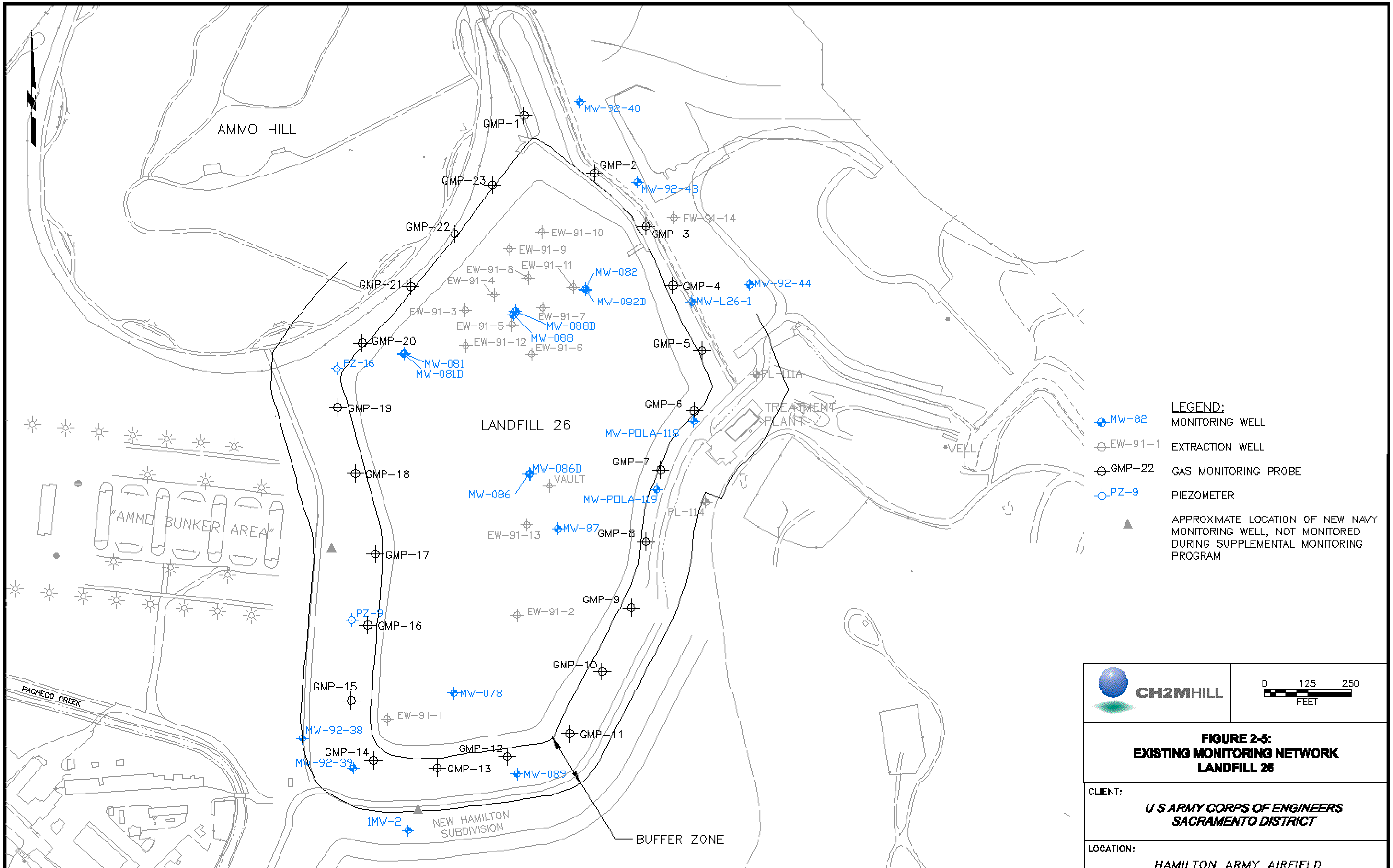
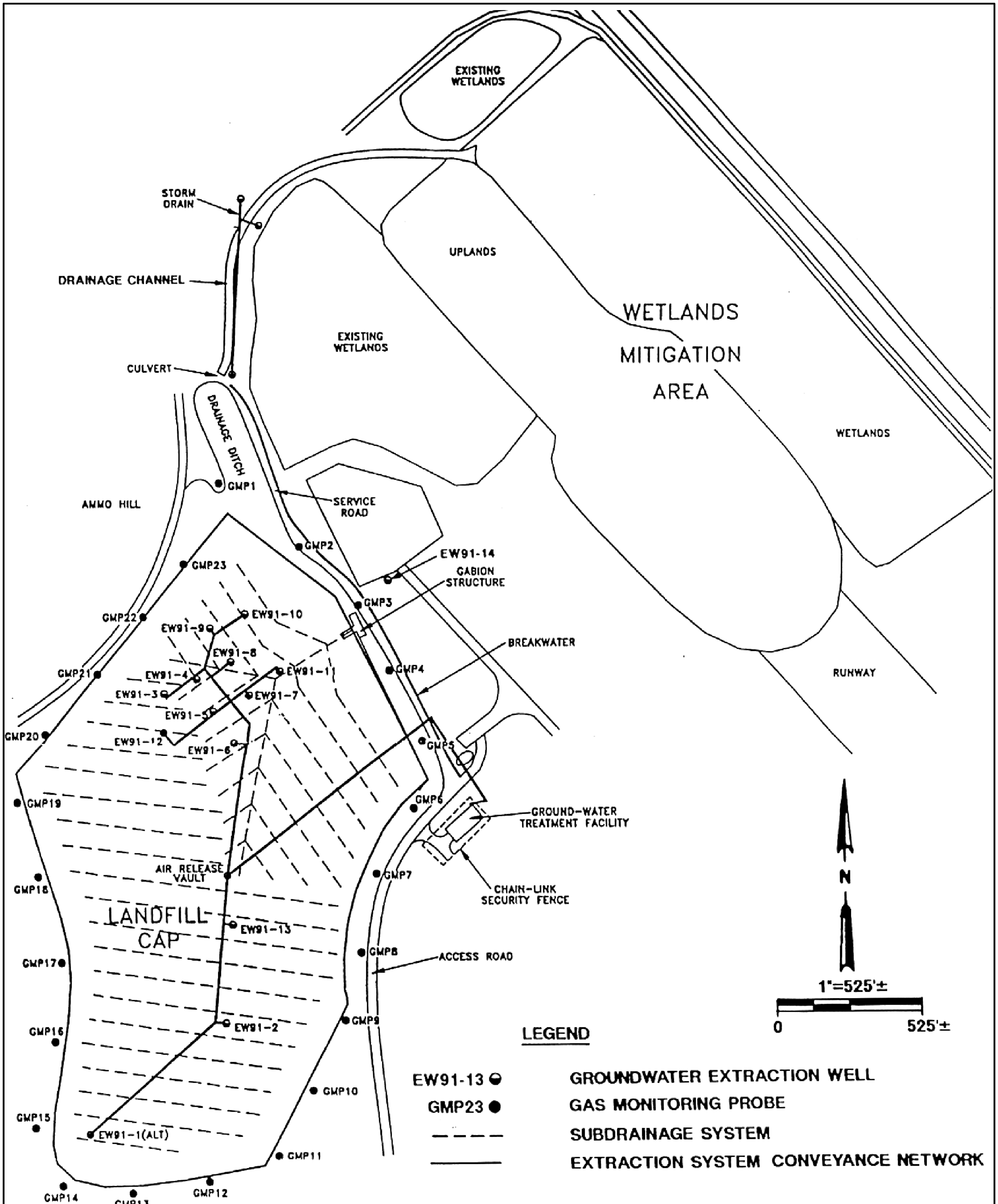


FIGURE 2-5:
EXISTING MONITORING NETWORK
LANDFILL 26

CLIENT:
U S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

LOCATION:
HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

Source: ITSI **Innovative Technical Solutions, Inc., 2001**



LEGEND

EW91-13	GROUNDWATER EXTRACTION WELL
GMP23	GAS MONITORING PROBE
– – – –	SUBDRAINAGE SYSTEM
———	EXTRACTION SYSTEM CONVEYANCE NETWORK

NOTE: GROUNDWATER MONITORING WELLS ARE NOT SHOWN.

SOURCE: U.S. ARMY CORPS OF ENGINEERS, FINAL DESIGN ANALYSIS, HAMILTON AFB, REMEDIAL ACTION, LANDFILL 26, PHASE II, VOL 1, JULY 1993

Figure 2-6
Landfill Gas Monitoring Probes and Groundwater Extraction Well System
Hamilton Army Airfield
Novato, California

CH2MHILL

163181.12.MS gas_monitor_probes.FH8 3-30-01 dash

2.5 Summary of Previous Investigations and Monitoring Data

Extensive investigations and monitoring activities have been conducted for HAAF Landfill 26. The scope of these investigations included detailed topographic and geophysical surveys, soil borings, groundwater and landfill gas monitoring well installation, groundwater and surface water quality, contaminant characterization, landfill gas, trenching operations, water levels, air quality, sediment quality, soil sampling, and stormwater drainage.

Investigations including landfill gas monitoring are summarized in Section 2.5.1. All other major investigations and regulatory actions for Landfill 26 are summarized in Appendix A. Specific methane monitoring results are summarized in Section 2.5.2. For reference purposes, a comprehensive list of methane data collected is included in Appendix B. Appendix C shows groundwater elevations for selected locations in the vicinity of Landfill 26.

2.5.1 Summary of Previous Landfill Gas Investigations

The following paragraphs provide a chronological list of previous landfill-gas-related investigations conducted at Landfill 26. Data are summarized in Section 5.2. A summary of other major investigations and regulatory actions are included in Appendix A.

1986

The first effort to collect methane data at Landfill 26 was part of a preliminary investigation conducted by WCC. The investigation concluded that Landfill 26 was non-methanogenic and the refuse zone (RZ) was in a state of near-perennial saturation. Four primary hydrologic horizons were characterized and groundwater-level fluctuations were recorded and were correlated with seasonal changes in precipitation. Other investigations are summarized in Appendix A.

1987-1991

No soil gas samples were collected between 1987 and 1991.

1992

Quadrel Services conducted a methane survey of Landfill 26 from September 14 to September 18, 1992. The goal of this investigation was to quantify the amount of methane being generated at Landfill 26, and to further delineate the boundaries of the landfill. This investigation was completed before the installation of the final landfill cap. A landfill gas collection tube was installed at a depth of 18 inches below ground surface (bgs) at 40 sampling locations in and around the landfill.

1993

The USACE installed six landfill gas monitoring probes to a total depth of 15 bgs within Landfill 26 in November or December 1993. Landfill gas sampling was conducted on January 20 and March 24, 1994.

1994

As part of landfill closure, Clark & Witham, Inc., installed a total of 23 gas monitoring probes (GMP-1 through GMP-23) in two phases (in May and July) around the perimeter of Landfill 26. The average spacing of the probes is approximately 200 feet, much less than the 27 CCR 20925 requirement of 1,000 feet maximum. Figure 1-4 shows the locations of the 23 gas monitoring probes.

Each gas-monitoring probe was completed at a total depth of 12 feet below grade. The screened interval in each probe extends from 6 to 11 feet below grade, which corresponds approximately to the base of the landfill (ranging from 7 to 12 feet below grade). The probes' gravel packs extend from 5 to 12 feet below grade and are overlain by 2 feet of bentonite pellets and 3 feet of neat-cement grout.

Soil gas sampling was conducted on a monthly basis for the first year after installation of the probes, beginning in August 1994. The gas samples were analyzed in the field for O2, N2, CO2, CH4, methylene chloride, and benzene using a portable gas chromatograph. A summary of the soil gas monitoring data is included in Section 2.5.2.

1995

Soil gas was collected and analyzed monthly continuing from the previous year, through September 1995. Gas Monitoring probes GMP-3 and GMP-5 were destroyed in May 1995 during construction around the Landfill 26 perimeter and were reinstalled in July 1995.

1996

Landfill gas was collected and analyzed one time in 1996.

1997-1998

No soil gas samples were collected in between 1997 and 1998.

1999

Soil gas was collected and analyzed in September, October, and December 1999. ITSI performed Soil gas sampling for September and December 1999. Gas probes GMP-4 through GMP-13 were monitored during September; all gas probes that could be monitored were monitored during each of two sampling events in December. Some gas probes were unable to be monitored because of high groundwater levels.

Harding Lawson Associates (HLA) obtained field methane readings for GMP-4 through GMP-10. Methane was detected in GMP-5, GMP-8, and GMP-9. HLA prepared a "Preliminary Methane Sampling Results at Landfill 26" memorandum for methane sampling performed on October 4 and 21, 1999. The memorandum provided methane results of direct-push soil gas samples collected adjacent to the gas-monitoring probes (GMP-5, GMP-8, and GMP-9) and at various lateral distances from these probes.

2000

ITSI prepared the *December 1999 Landfill Gas Monitoring Report* (ITSI, 2000). This report contains the results of gas-probe monitoring and sampling. During two monitoring events in December 1999, 23 gas probes were monitored and 20 gas probes were sampled.

In November, ITSI completed the *Draft September 2000, Landfill Monitoring Report* for Landfill 26. This report summarized monitoring activities and data for the annual groundwater, surface water, and landfill-gas-monitoring event.

2001

In January, ITSI completed the *HAAF Draft Landfill Gas Migration Study*. The study evaluated the presence, distribution, and migration of landfill gas along the eastern margin of Landfill 26. Nine periodic gas monitoring events were performed at an interval of every 2 to 3 weeks from July 13 through December 15.

2.5.2 Summary of Methane Monitoring Data

This section summarizes the Landfill 26 methane data from soil gas and groundwater monitoring activities since 1986. Soil gas data, including LEL readings, CH4 (methane) O2, CO2, and N2 measurements for GMP-1 through GMP-23 since installation in 1994 are included in Appendix B.

Table 2-1 provides a summary of soil gas results for methane collected from various locations in and around the landfill between 1986 and 2000.

TABLE 2-1
Summary of Soil Gas Methane Monitoring Results, 1986 through 2000
Landfill 26, Hamilton Army Airfield

Methane Study	Locations Sampled	Summary of Results (values in % methane by volume)
1986: WCC conducted a preliminary investigation for Landfill 26, which included a methane study	Various locations throughout the landfill area.	Investigation concluded that Landfill 26 was nonmethanogenic
1992: Quadrel Services conducted a methane survey of Landfill 26 from September 14 to September 18	A soil gas collection tube was installed at a depth of 18 inches bgs at 40 sampling locations throughout and adjacent to the landfill.	All methane data collected was below 0.1% by volume
1993 : USACE installed six soil gas monitoring probes to a total depth of 15 bgs within Landfill 26	Various locations within and adjacent to the landfill.	Four of the 12 methane readings taken on these dates were above 0.1% by volume. All four detections were within the landfill. Probe #2 : 33% on 1/20/93 and 32% on 3/24/93. Probe #3 : 2.5% on 3/24/93. Probe #4 : 1.9% on 3/24/93.
1994-1996: A perimeter soil gas monitoring network, consisting of 23 landfill gas probes (GMP-1 through GMP-23) was installed in 1994. Monitoring was conducted between August 1994 and June 1996.	Soil gas was sampled on 14 different occasions between installation in 1994 and 1996. Because of high water levels, not all probes were sampled during each monitoring event.	Methane was detected above 0.1 percent by volume in four gas probes during this period: GMP-2 : 0.23% on 9/12/95 GMP-3 : 1.5 % on 9/12/95 GMP-5 : 0.28% and 5.7% on 9/12/95 and 6/26/96 respectively GMP-8 : 0.23% on 6/26/96

TABLE 2-1
Summary of Soil Gas Methane Monitoring Results, 1986 through 2000
Landfill 26, Hamilton Army Airfield

Methane Study	Locations Sampled	Summary of Results (values in % methane by volume)
1999: Soil gas sampling was conducted during September by ITSI	GMP-5 through GMP-14	Methane was detected above 0.1% in two gas probes: GMP-5 : 17.3% GMP-9 : 9.8%
1999: HLA took methane readings in October at selected probes	GMP-4 through GMP-10	Methane was detected above 0.1% at two locations: GMP-8 : 0.28% GMP-9 : 0.6%
1999: Soil gas sampling was conducted during December 7-8 and 28-29 by ITSI.	GMP-1 through GMP-23 on both December 7-8 and 28-29	Methane was detected above 0.1% at one location: GMP-13 : 0.18%
2000: ITSI conducted supplemental landfill gas monitoring for Landfill Gas Migration Study from July 2000 through year end.	GMP-5 through GMP-14 MW-78, MW-81, MW-81D, MW-82, MW-86, MW-86-D, MW-87, MW-89, MW92-38, MW92-39, MW92-43, MW-L26-1, MW-PL-111A, MW-PL-114, MW-POLA-118, MW-POLA-119, PZ-9 Direct Push Borings adjacent to GMPs where water levels were above screened intervals, and areas of suspected landfill gas Dissolved methane samples from five selected GMPs (GMP-5, GMP-7, GMP-9, GMP-11 and GMP-13)	Locations with field readings above 1% LEL or 0.05% methane: GMP-5, GMP-7, GMP-8, GMP-9, GMP-13, MW-78, MW-81, MW-81D, MW-82, MW-86, MW-86D, MW-87, MW92-43 Four of the 11 GMPs (GMP-5, GMP-8, GMP-9 and GMP-13) had methane concentrations of 1 percent or greater during one or more events. Methane was present near GMP-9 at concentrations greater than 5 percent during each sampling event from July through early November, while methane was observed near GMP-5 and GMP-13 at these concentrations only seasonally Direct-push samples : Three areas adjacent to the landfill detected methane concentrations greater than 5 percent by volume, near GMP-9 and GMP-13, and near GMP-5 Dissolved methane : Levels were consistently greater than 100 :g/L at GMP-5, GMP-9, and GMP-13, and were generally below 20 :g/L at GMP-7 and GMP-11. Dissolved methane concentrations in the refuse-zone wells sampled were 1,500 to 3,000 :g/L in MW-78, MW-82, MW-86 and MW-87; MW-81D is screened in the alluvium below the refuse zone, and had 140 :g/L dissolved methane.

TABLE 2-1
Summary of Soil Gas Methane Monitoring Results, 1986 through 2000
Landfill 26, Hamilton Army Airfield

Methane Study	Locations Sampled	Summary of Results (values in % methane by volume)
2000: ITSI conducted annual soil gas monitoring in September.	GMP-5 through GMP-15 were monitored GMP-5 through GMP-11 and GMP-13, GMP-14 and GMP-15 were sampled	Methane was detected above 0.1% at four locations: GMP-5 : 1.0% GMP-8 : 0.8% GMP-9 : 21% GMP-13 : 0.70% (estimated)

Table 2-2 presents a summary of soil gas methane data with concentrations greater than 5 percent by volume.

TABLE 2-2
Summary of Soil Gas Methane Data Greater than 5 Percent by Volume
Landfill 26, Hamilton Army Airfield

Location	Type	Date Sampled	Methane (% by volume)	Total Samplings	Detect % (>5% Methane)
Probes within Landfill Prior to Cap Construction					
Probe #2	Gas monitoring probe in the soil	1/20/93 3/24/93	33 32	4	50%
Perimeter Soil Gas Monitoring Probes					
GMP-5	Perimeter Soil gas monitoring probe	6/26/96 9/1/99	5.7 17.3	29	6.9%
GMP-8	Perimeter soil gas monitoring probe	11/2/00 11/3/00 11/28/00	>5 (LEL) 6.1 7.6	26	11.5%
GMP-9	Perimeter soil gas monitoring probe	9/1/00 7/14/00 7/27/00 7/28/00 8/10/00 8/11/00 8/29/00 9/8/00 9/11/00	9.8 12 >5 (LEL) 25 >5 (LEL) 26 6.1 >5 (LEL) 21	31	29%
GMP-13	Perimeter soil gas monitoring probe	10/12/00 10/13/00	>5 (LEL) 21	30	6.7%
Groundwater Monitoring Wells					
MW-78	Groundwater monitoring well	12/14/00	>5 (LEL)	9	11.1%
MW-81	Groundwater monitoring well	8/28/00 9/8/00 11/2/00	>5 (LEL) >5 (LEL) >5 (LEL)	9	44.4%

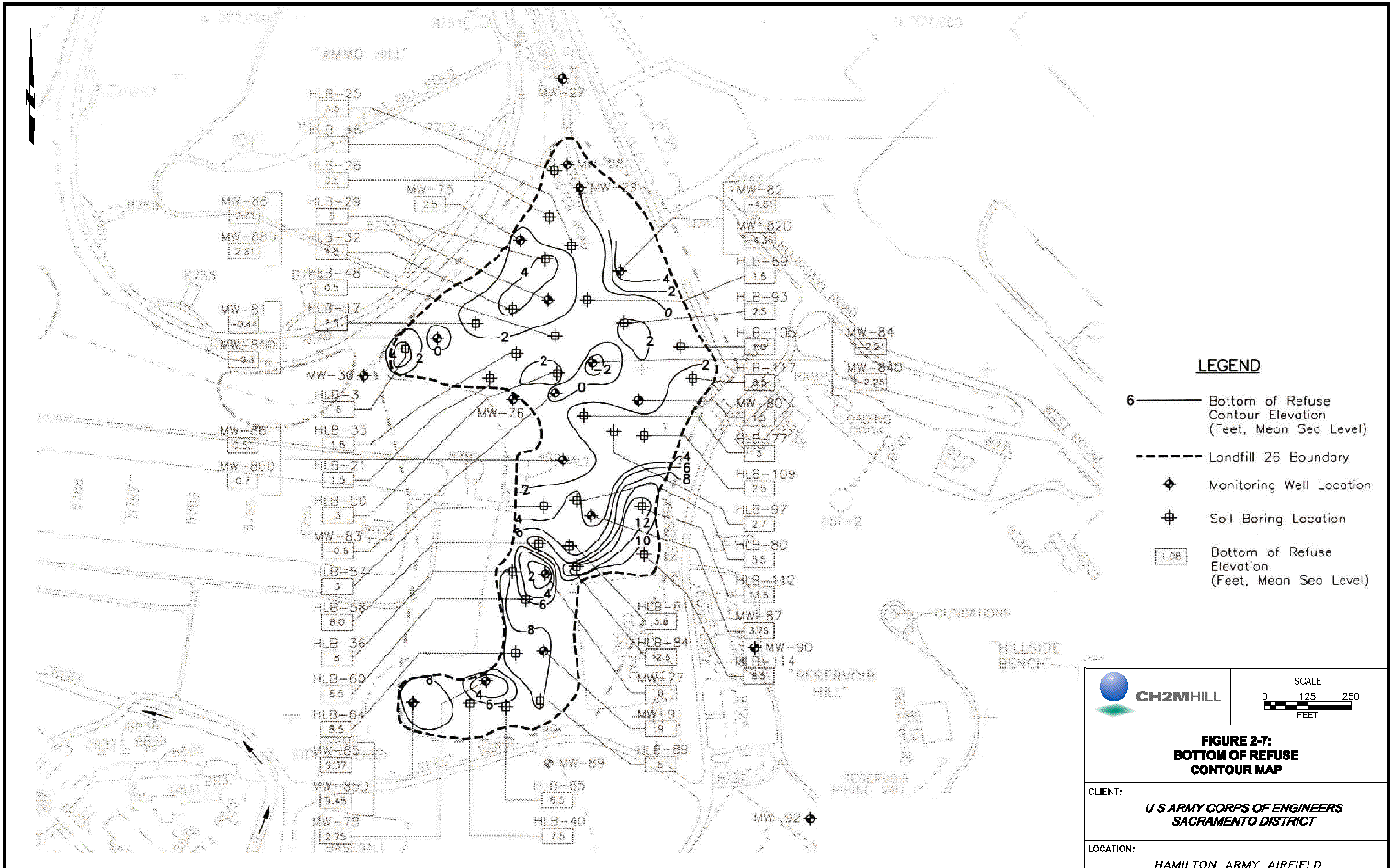
TABLE 2-2
Summary of Soil Gas Methane Data Greater than 5 Percent by Volume
Landfill 26, Hamilton Army Airfield

Location		Type	Date Sampled	Methane (% by volume)	Total Samplings	Detect % (>5% Methane)
			11/27/00	>5 (LEL)		
MW-81D		Groundwater monitoring well	9/8/00 12/14/00	>5 (LEL) >5 (LEL)	9	22.2%
MW-82		Groundwater monitoring well	7/13/00 7/27/00 8/10/00 8/28/00 9/8/00 10/12/00 11/2/00 11/27/00 12/14/00	>5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL) >5 (LEL)	9	100%
MW-86		Groundwater monitoring well	11/27/00 12/14/00	>5 (LEL) >5 (LEL)	9	22.2%
MW-86D		Groundwater monitoring well	11/27/00 12/14/00	>5 (LEL) >5 (LEL)	9	22.2%
MW-87		Groundwater monitoring well	11/2/00 11/27/00	>5 (LEL) >5 (LEL)	5	40%
Direct-Push Borings Near Gas Monitoring Probes						
GMP-5	DP37	Direct-Push Boring	10/13/00	50	1	100%
GMP-9	DP9 DP12 DP18 DP19 DP44	Direct-Push Boring	7/28/00 8/11/00 8/28/00 8/29/00 11/3/00	30 8.9 20 6.8 8.9	1	100%
GMP-12	DP52 DP57	Direct-Push Boring	11/28/00 12/15/00	16 13	1	100%

LEL= Lower Explosive Limit. Reading was taken in the field as percent of the LEL. 100% LEL= 5% methane by volume.

2.6 Geologic and Hydrogeologic Information

HAAF is situated on reclaimed mudflats of the San Pablo Bay and bedrock east of steep coastal range mountains that rise to more than 1,500 feet above mean sea level (msl). HAAF is bounded by a system of dikes and levees on the north and east sides. Much of the site consists of fairly flat land, with elevations below sea level. Currently, a perimeter ditch and system of drains and pumps keeps the water table at a depth of at least 2 feet below ground surface (bgs) throughout HAAF. Remaining portions of the site consist of steep, highly eroded hills. LF 26 is situated in a topographic valley between Ammo Hill and Reservoir Hill. Pre-landfill topography can be approximated by the bottom of refuse contour map (Figure 2-7) prepared by WCC (WCC, 1997). Some excavation occurred before filling; no post-excavation topographic maps are available. Borings through the landfill have revealed



CH2MHILL

FIGURE 2-7:
BOTTOM OF REFUSE CONTOUR MAP

CLIENT:
U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

LOCATION:
HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

Source: Woodward-Clyde Federal Services, 1999

refuse thickness ranges from 0 to 11 feet (WWC, 1997). Figure 2-8 presents a contour map representing the top of the refuse.

2.6.1 Topography

Landfill surface elevations following completion of the RCRA application range from approximately 4 to 21 feet above msl around the perimeter to approximately 28 feet above msl at the crest. This topography is representative of the Landfill 26 grades between closure of the landfill in 1995, and up to June 1998, at which time grading modifications were performed to improve the Landfill 26 drainage conditions. The site features, as of August 1998, and as-built elevations are presented in the September 1998 CQA report for the grading/drainage modification (CH2M HILL, 1998c).

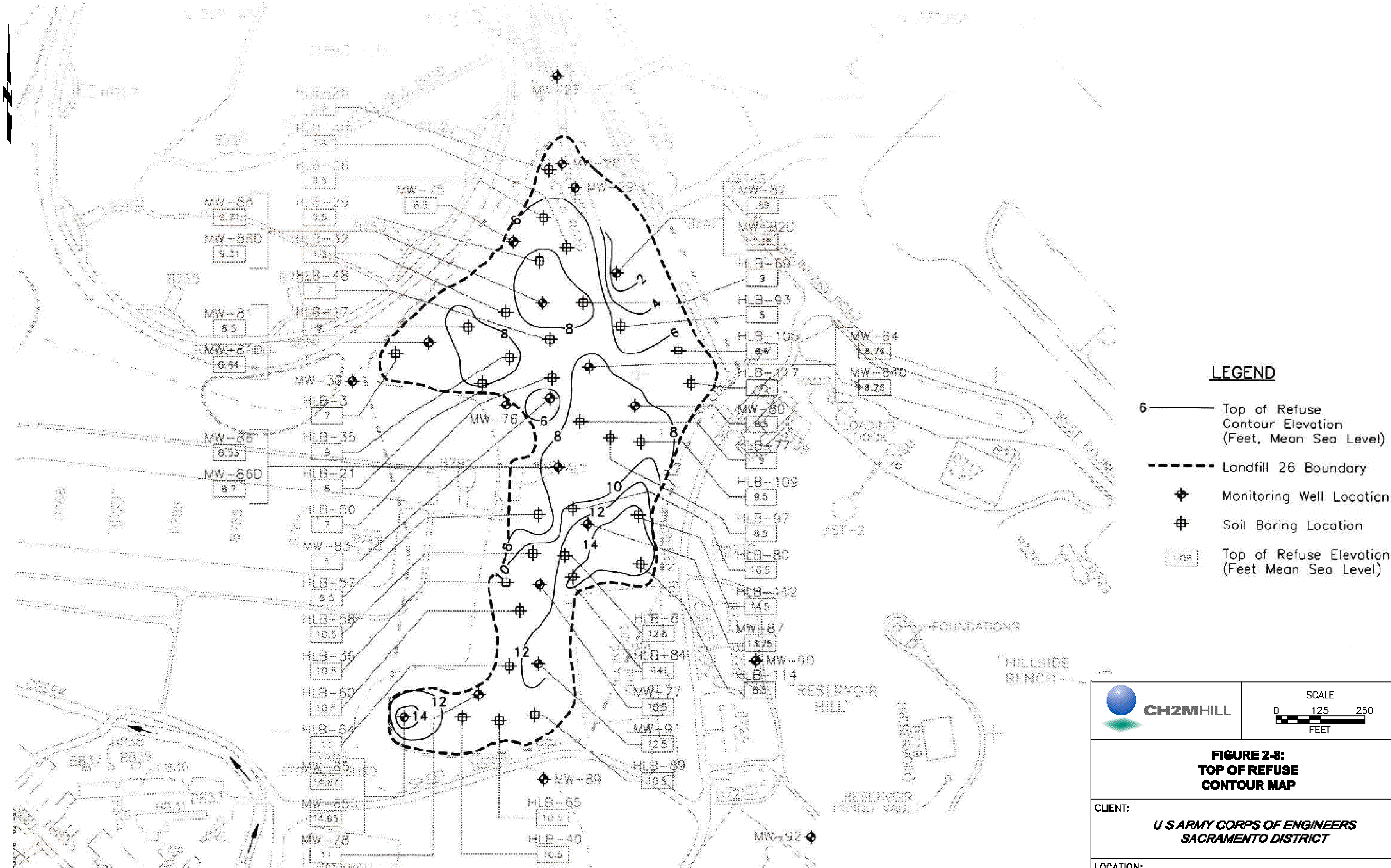
2.6.2 Hydrology

HAAF is in the southern portion of the Novato Creek Drainage Basin and Watershed (USACE, 1993). Regional surface flow is generally from the upland areas in the west toward the San Pablo Bay in the east. Novato Creek is the main surface drainage unit into which smaller drainages flow. Two such smaller drainages, Arroyo San Jose and Pacheco Creek, occur along the northwestern boundary of HAAF, in the vicinity of Landfill 26. These drainages flow northerly into Ignacio Reservoir, just north of Ammo Hill.

Currently, surface water flowing from Landfill 26 is conveyed through a network of drainage ditches to the mitigation wetland and then to the perimeter drainage ditch that discharges to San Pablo Bay. The drainage around the landfill is shown on Figure 2-9. A drainage system modification, a diversion berm to prevent Pacheco Creek overflow from reaching the Landfill 26 perimeter drainage system, was constructed during July and August 1998. This diversion berm and other Landfill 26 grading and drainage modifications were constructed during the summer of 1998. The topographic and hydrologic changes affected the surface water movement around Landfill 26, but not the overall conveyance to San Pablo Bay.

2.6.3 Geology

HAAF is located within the San Francisco Bay structural block (Bay Block) in the north Coast Range physiographic province of California (WCC, 1997). A general geologic map for Landfill 26 is shown in Figure 2-10. Faulting has resulted in a prominent northwest-trending structural grain and is best displayed by the trend of the San Andreas fault system, which occurs approximately 17 miles to the west. The geology of HAAF is characterized by two distinct units: Cretaceous age (65-144 million years ago) rocks of the Franciscan Complex, and overlying Quaternary (includes last 2 million years) sediments. The Franciscan rocks are composed of arkosic wacke sandstones (less than 5 percent feldspar and less than 15 percent mud matrix within the sandstone), which are exposed in the upland area of Ammo and Reservoir Hills. The Franciscan rocks are massive (lacking form or structure), jointed, and highly fractured. The sandstones are highly weathered in the lowland areas where they underlie the younger sediments and make up the basement rock of the region. The surface of the basement complex is very irregular as a result of cross-cutting meandering streams. On the southeastern side of Reservoir Hill, localized fractured and



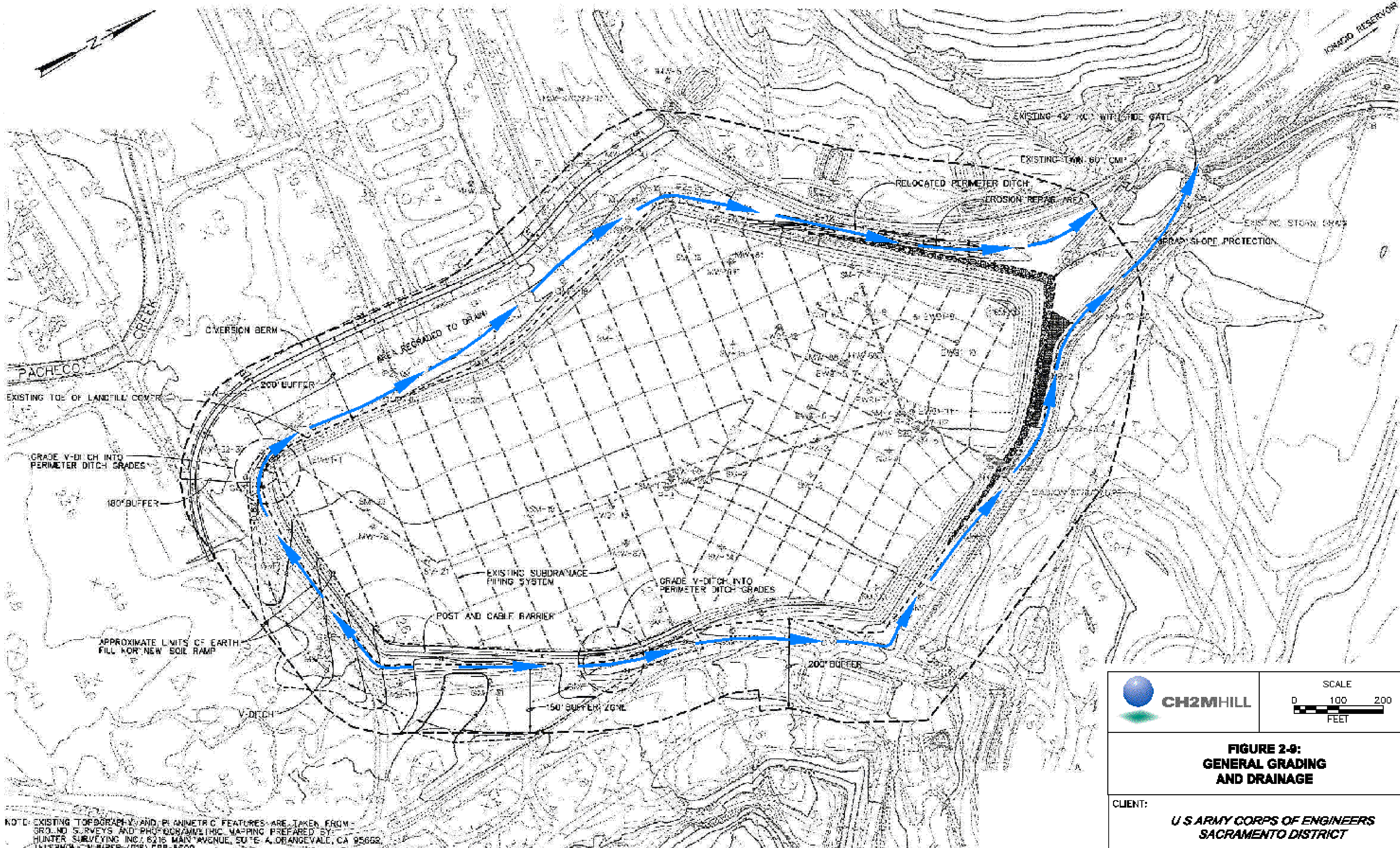
CH2MHILL

FIGURE 2-8:
TOP OF REFUSE
CONTOUR MAP

CLIENT:
U S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

LOCATION:
HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

Source: Woodward-Clyde Federal Services, 1999



NOTE: EXISTING TOPOGRAPHY AND PLANIMETRIC FEATURES ARE TAKEN FROM GROUND SURVEYS AND PHOTOGRAMMETRIC MAPPING PREPARED BY: HUNTER SURVEYING INC., 6216 MAIN AVENUE, SUITE A, ORANGEVALE, CA 95662, TELEPHONE NUMBER (916) 988-5600.

DATE OF PHOTOGRAPHY: NOVEMBER 25, 1996 AND FEBRUARY 13, 1997.

LEGEND:

SURFACE DRAINAGE FLOW DIRECTION

CH2MHILL

SCALE

0 100 200

FEET

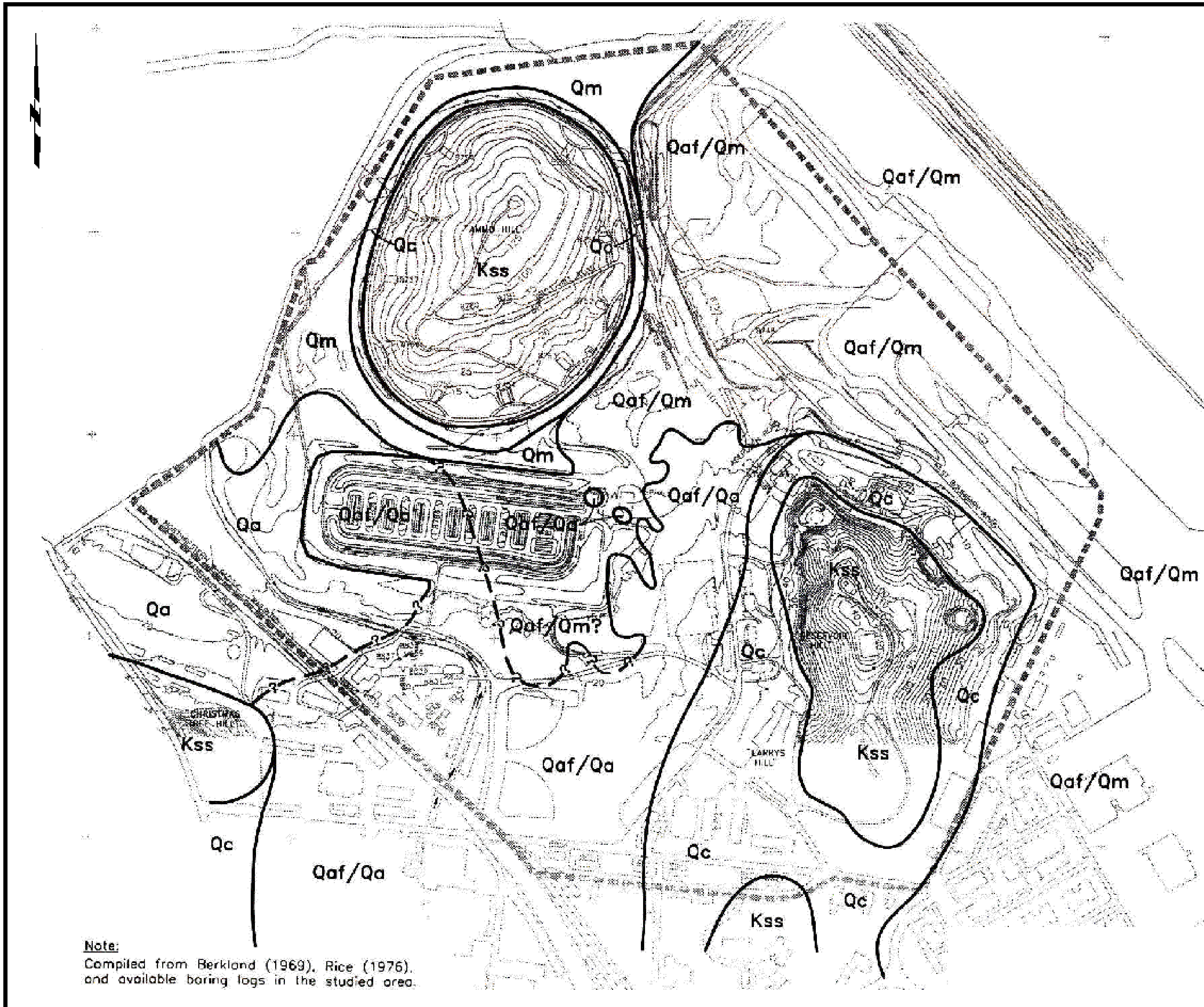
FIGURE 2-9: GENERAL GRADING AND DRAINAGE

CLIENT:

U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

LOCATION:

HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA



LEGEND

Boundary of Study Area (WCC, 1987)

Geologic Contact

—?—?— Geologic Contact Uncertain

GEOLOGIC UNITS

Qaf Artificial Fill. Deposits of rock, soil, refuse or Bay Mud. Reworked engineering purposes. Highly variable from place to place. Qaf/Qm indicates fill placed on Bay Mud. Qaf/Qa inidicates fill placed on Alluvium.

Qc Colluvium. Unconsolidated and unsorted soil material and weathered rock fragments that accumulated at the base of slopes by gravitational or slope wash processes. Derived by weathering and decomposition of bedrock material underlying the slopes. Covers most slopes but mapped only where assumed to be more than 5 feet thick.

Qa Alluvium. Unconsolidated deposits of clay, silt, sand, and gravel underlying the bottom lands of the main stream valleys. Consists of materials transported and deposited by the streams.

Qm Bay Mud. Marshlands, former marshlands, and mudflats bordering San Pablo Bay. Mostly at or below mean sea leve. Thick deposits of unconsolidated,low-density, semi-fluid, highly compressible, highly impermeable silty clay to clay. Rich in disseminated peaty material. Contains localized sand lenses (especially near hills). Plastic and swells when wet, shrinks and hardens dry (dessicated Bay Mud).

Kss Sandstone. Mainly thickly bedded, medium-to coarse grained sandstone with subordinate siltstone. Composed predominantly of fairly well sorted, angular to subrounded grains of quartz and feldspar, with fine-grained matrix (graywacke).

CH2MHILL

SCALE
0 250 500
FEET

FIGURE 2-10: GEOLOGIC MAP OF THE LANDFILL 26 AREA

CLIENT:

U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

LOCATION:

HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

Note:
Compiled from Berklond (1969), Rice (1976), and available boring logs in the studied area.

Source: Woodward-Clyde Federal Services, 1999

sheared shale beds occur. Quaternary units consist of alluvial and fluvial sediments mixed with fill materials (USACE, 1993). The Burdell Mountain fault is the nearest fault with probable quaternary displacement. This strike-slip fault trends northwesterly and projects beneath Bay deposits approximately 3 miles north of Landfill 26 (Wagner and Bortugno, 1982). No significant seismic activity has been recorded along this fault (Wong, 1991).

Deposits of clay and silt (Bay Mud) are located beneath present and former marshlands bordering the San Francisco Bay, including portions of HAAF and Landfill 26. The Bay Mud is semi-consolidated or unconsolidated, contains variable amounts of organic material and shell fragments, and is soft when water saturated (WCC, 1997). Stream and tidal channel deposits irregularly intersect the Bay Mud beneath Landfill 26 and appear as discontinuous layers of silt, sand, and gravel (WCC, 1997). The Bay Mud layer appears to overlay the alluvium geologic unit (IT, 1998a). The thickness of the Bay Mud layer varies considerably and is estimated to be 20 feet thick just north of Landfill 26 (WCC, 1997). Because Bay Mud at HAAF typically contains much more water by weight than solid matter (Rice, et al., 1976), the Bay Mud will flow laterally under the influence of localized pressures such as placement of thick fills (Rice, et al., 1976).

Four major hydrogeologic horizons (refuse, bay mud, alluvium, and bedrock) have been identified at Landfill 26 (WCC, 1997; IT, 1999). These four major horizons are summarized in the following text.

- **Refuse Layer:** This unit consists of debris mixed with clayey to gravely fill disposed of from the 1940s through the 1970s. The debris is composed predominantly of construction debris, wood, bottles, paper, steel, wire, and other municipal waste. The refuse layer is approximately 5 to 8 feet thick and is mostly saturated by groundwater (IT, 1999).
- **Bay Mud:** The Bay Mud is soft to firm clay and silt that occurs primarily under the northern half of Landfill 26 and the Bay Plain to the north. The Bay Mud was deposited during the late Quaternary Period (within the past 12,000 years) and ranges from 0 to 15 feet thick beneath Landfill 26. In the northern half of the landfill, the Bay Mud generally isolates the refuse from the underlying alluvial deposits and restricts the downward migration of Landfill 26 contaminants of concern (COCs). The Bay Mud is not present in some areas within the landfill, such as the locations of MW-82 and MW-82D. The Bay Mud is also absent in most borings and wells located on the southern portion of the landfill.
- **Alluvium:** Quaternary alluvial deposits, consisting primarily of sandy clay, clayey sand, and sand underlie the Bay Mud and are in contact with the refuse on the southern half of Landfill 26. Alluvial sand deposits containing little or no fines have been interpreted as stream channel deposits (WCC, 1997).
- **Bedrock:** Cretaceous arkosic sandstone of the Franciscan Complex underlies the alluvium throughout the site and is exposed on Ammo Hill, POL Hill, and Reservoir Hill. Water is transmitted through fractures present near the top of this bedrock unit; but these fracture networks are not laterally extensive or are not connected over great distances in local Franciscan Bedrock (ESI, 1993).

In addition to the four major horizons, the RCRA-type cap and cover layer overlies the layers that compose the subsurface at the site. The cap has influence on the groundwater elevations within the landfill and with groundwater elevations directly adjacent to the landfill perimeter where precipitation is directed via the cap subdrainage system.

Section 2.4 of this report provides greater detail regarding the RCRA-type cap.

2.6.4 Hydrogeology

Groundwater in the area of Landfill 26 flows to the northwest beneath most portions of the landfill, and to the north and northeast beneath the northeastern part of the landfill. Figure 2-11 shows the groundwater gradient for September 2000.

Recharge to the saturated subsurface in the area of Landfill 26 is derived from seasonal precipitation and subsurface flow from the alluvial valley south and southeast of the landfill. Additionally, a minor amount of groundwater may be supplied by the adjoining bedrock uplands. According to the *Draft Landfill Gas Migration Study at LF 26, HAAF*, it is apparent that the landfill cap prevents precipitation infiltration into the landfill, but also prevents evaporation of groundwater from the landfill (ITSI, 2001). Groundwater discharges downgradient at a relatively slow rate to the area north of the landfill, which is underlain by the Bay Mud. Additional groundwater discharge may be occurring because of evapotranspiration north of and adjacent to the landfill. According to the *Summary Technical Report for Landfill 26 at HAAF, Geological and Technical Data Analysis*, the high evaporation rate induced by dry weather conditions during the summer will result in desiccation of the fill and shallow Bay Mud (WCC, 1997).

HAAF's saturated subsurface consists of a series of sand and gravel fluvial channels bounded by alluvial clayey sand, silt, and sandy clay, all of which overlie and are laterally bounded by fractured and weathered sandstone bedrock. Figure 2-12 presents the approximate lateral distribution of these geologic units. Bedrock forms topographic highs to the southeast and northwest of Landfill 26.

The channel sand and alluvial units comprise a semi-confined aquifer. This aquifer has a maximum thickness of approximately 22 feet in the northern half of the Landfill 26 area and pinches out at the margins of the topographic highs. The average thickness of the aquifer is approximately 15 feet in the northern half of the Landfill 26 area and approximately 5 to 6 feet in areas of the southern half of the landfill. An area of thin alluvial deposits and no channel sands occurs within the semi-confined aquifer near the middle of the landfill. This area appears to divide the aquifer into two semi-independent aquifers. The lower aquifer is overlain by the Bay Mud unit, which acts as a partially confining layer. The Bay Mud averages 12 feet thick in the northern half of the landfill and 4 feet thick in the southern half. This unit is overlain by the landfill refuse and fill material, which acts as an unconfined aquifer. The unconfined aquifer reaches a maximum thickness of 11 feet in the north half of the landfill and is an average of 4 to 8 feet thick over much of the site.

Previous studies at HAAF indicate a consistent shallow aquifer gradient flowing from the southeast at Reservoir Hill, then to the northwest under Landfill 26, then to north-northeast downgradient from Landfill 26 (WCC, 1997). The unconfined and shallow groundwater at Ammo Hill was expected to follow a similar pattern to Reservoir Hill of radial flow from the

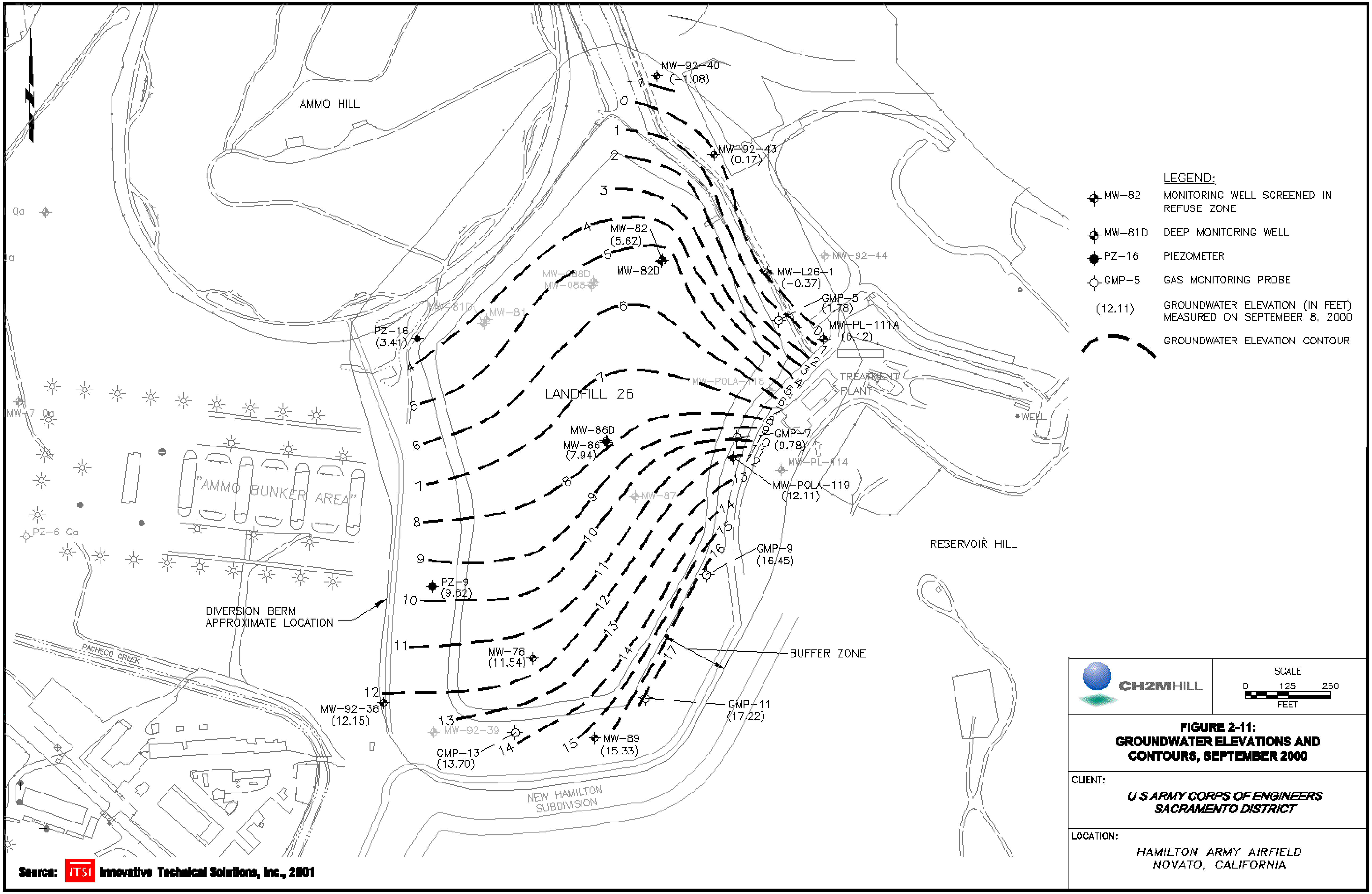


FIGURE 2-11: GROUNDWATER ELEVATIONS AND CONTOURS, SEPTEMBER 2000

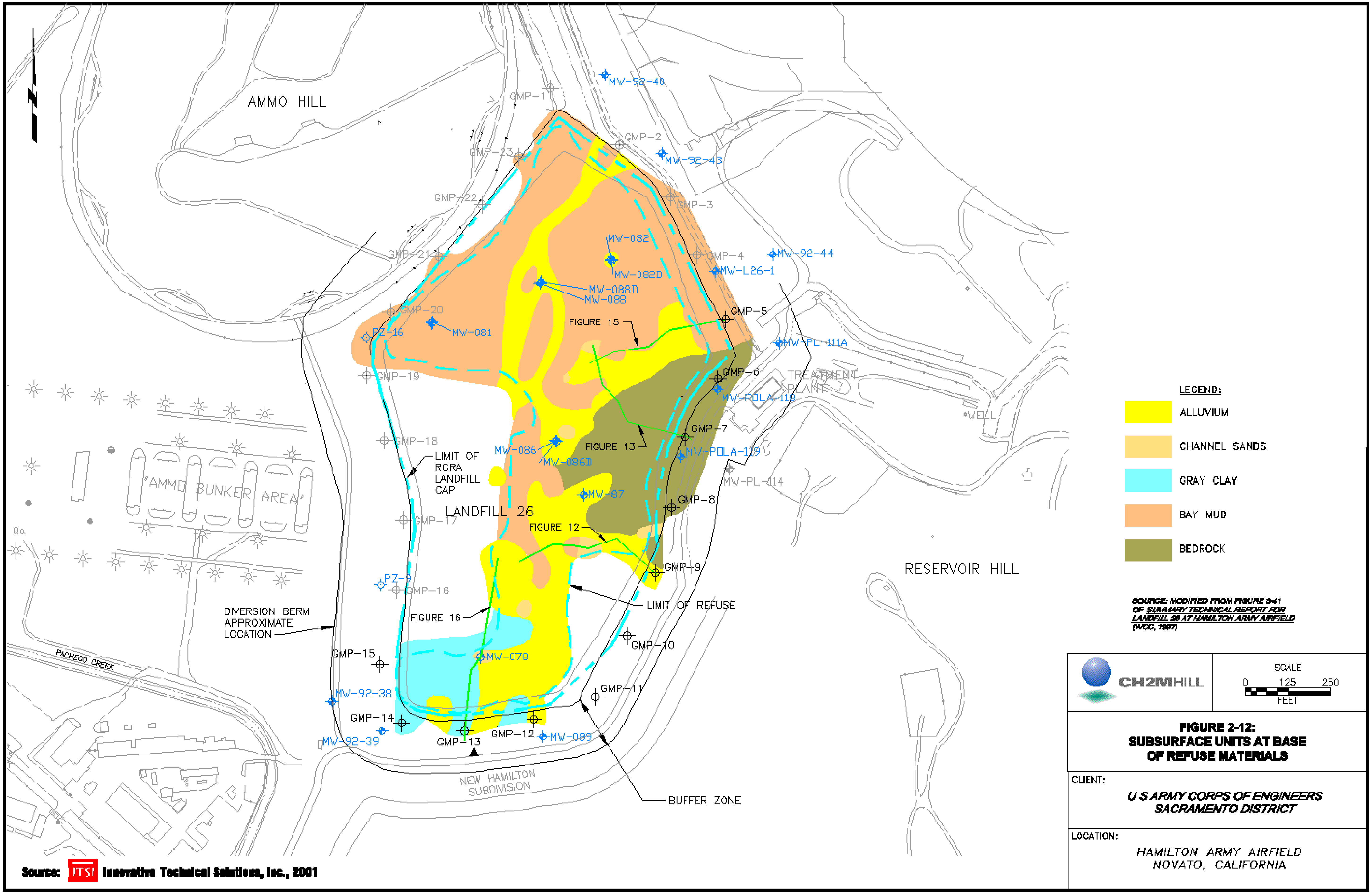


FIGURE 2-12:
SUBSURFACE UNITS AT BASE OF REFUSE MATERIALS

CLIENT:
U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

LOCATION:
HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

hill. There is little information about the flow from Ammo Hill. Previous studies indicate hydraulic gradients as follows (WCC, 1997):

Upgradient—from 1.16 x 10-2 to 2.7 x 10-2 ft / ft (1.65 x 10-2 ft / ft average)

- Beneath the southern part of Landfill 26—from 1.05 x 10-2 to 2.5 x 10-2 ft / ft (1.79 x 10-2 ft / ft average)
- Beneath the northern part of Landfill 26—from 4.25 x 10-3 to 7 x 10-3 ft / ft (5.13 x 10-3 ft / ft average)
- Within the refuse (southern part of Landfill 26)—9.3 x 10-3 to 2 x 10-2 ft / ft (1.31 x 10-2 ft / ft average)
- Within the refuse (northern part of Landfill 26)—4.2 x 10-3 to 1.33 x 10-2 ft / ft (8.97 x 10-3 ft / ft average)

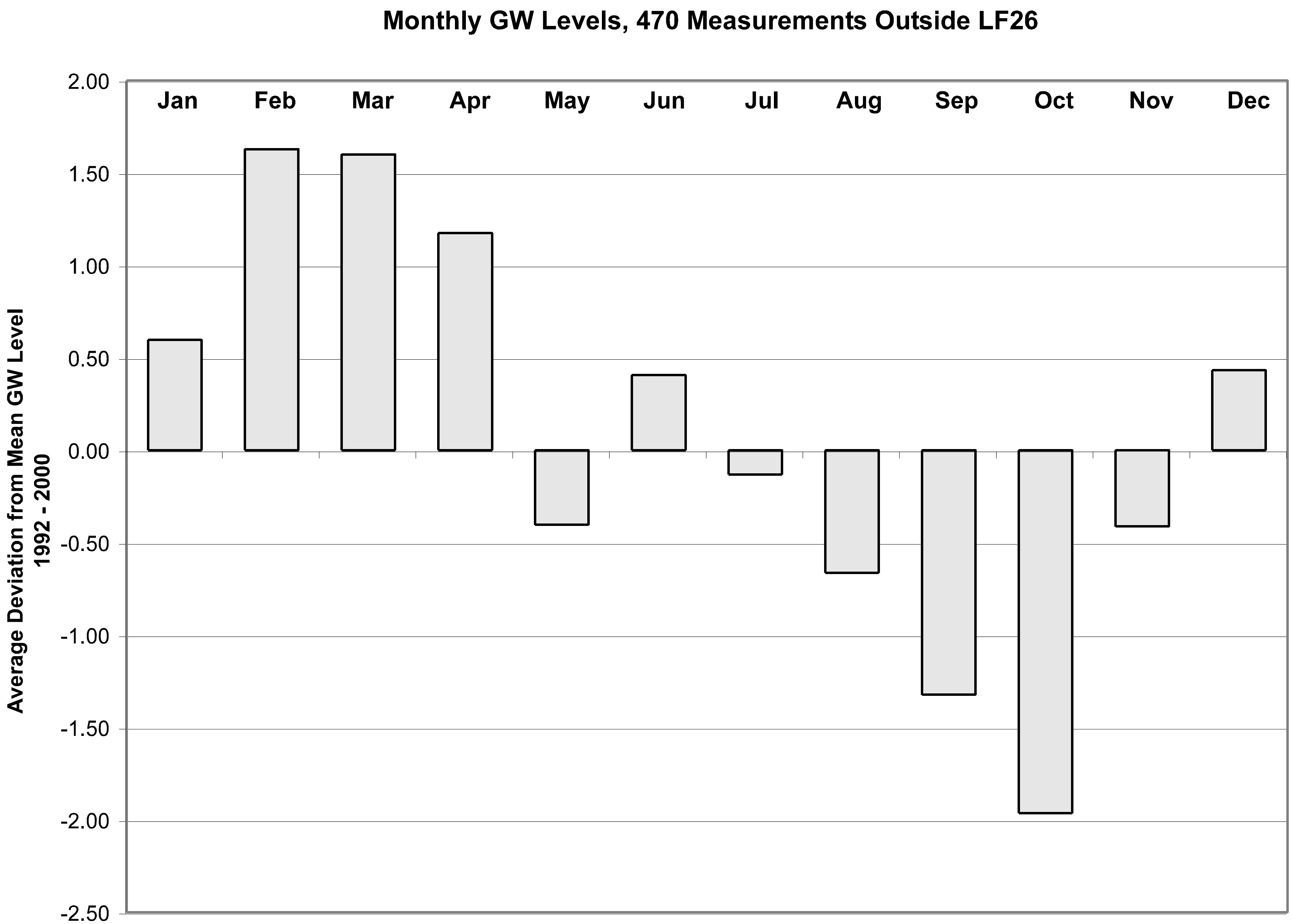
Historical groundwater elevation data indicate that the refuse zone is partially to completely saturated and is unconfined. The Bay Mud is saturated and acts as an aquitard where it is present beneath Landfill 26 refuse. The alluvium underlying the refuse zone is unconfined in the southern half of the landfill, and semi-confined to confined in the northern half where Bay Mud overlies alluvium. Groundwater beneath Landfill 26 should not be considered a source for domestic or municipal water supplies. According to the California SWRCB (Resolution 88-63) and the Water Quality Control Plan for the San Francisco Bay Region, it is not suitable for drinking water because of a high total dissolved solids (TDS) concentration and a low sustainable yield (WCC, 1997).

Seasonal differences in rainfall have a significant impact on groundwater elevations in the Bay Mud. In winter and spring, groundwater elevations are close to the surface; in summer, elevations may drop to 12 feet bgs. This situation causes desiccation of the upper Bay Muds, extending as deep as 10 feet bgs. The desiccated portion appears to have been excavated from Landfill 26. This material was probably used for dikes around active disposal areas and was not necessarily mixed with refuse (WCC, 1997).

Seasonal groundwater level variation across the site was evaluated using all wells for which water levels have been collected. Data from 1992 were collected, and wells outside the landfill were selected if water levels had been measured at least 10 times. For these wells, an average water level was calculated, and for each measurement this produced a “deviation” from the average for that well. (For example, this would produce values of –0.12, +0.20, +0.35, etc., for a given well on the dates the level was measured.)

Measurements (of deviation from well average) were then grouped by month, and the deviations were averaged. This produced an average deviation, by month, as shown on Figure 2-13. On this graph, the seasonal pattern is clear,, with groundwater levels highest, on average, in February and March, and lowest, on average, in October.

The groundwater within the landfill zone appears to respond differently to precipitation than do the wells outside of the landfill zone. The landfill cap prevents infiltration within the landfill, forcing precipitation toward the surrounding flood drainage ditch. Although



Note: Fewer than ten data points were available for the months of January, February, & May.

Figure 2-13
Monthly Groundwater Levels
Hamilton Army Airfield
Novato, California

the groundwater levels within the landfill are not immediately influenced by storm events, the levels appear to respond to rising and lowering regional groundwater flow. The groundwater surrounding the capped landfill appears to respond nearly instantaneously to seasonal precipitation.

The regional groundwater gradient in the southern area of Landfill 26 is generally toward the north-northwest. However, in the southern part of Landfill 26, the gradient is toward the west-northwest. The gradient in this area and factors controlling gradient and flow direction are not fully understood. The USACE is conducting additional studies, including an upgradient groundwater study to more thoroughly monitor and characterize groundwater flow in the area south of Landfill 26.

2.7 Data Evaluation

Although some uncertainty exists regarding the specific technical basis for the generation, release and migration of methane from the landfill, the available information appears to be sufficient to:

- Draw general conclusions regarding the generation, presence and migration of methane at and near Landfill 26 (described in Section 3)
- Evaluate the need to control methane at Landfill 26 (provided in Section 3)
- Identify and evaluate conceptual approaches for remedial options (Sections 4 and 5)
- Recommend a conceptual approach to remediate methane migrating from Landfill 26 (Section 6)
- Identify additional data requirements to provide additional certainty for the technical basis for placement and design of remedial options